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SERVICE AND REGULATORY ANNOUNCEMENT C&MS NO. 135

JUN 16 1966

X3 OFFICIAL STANDARDS OF THE UNITED STATES
FOR GRADES OF WOOL

CURRENT SERIAL RECORDS

(Title 7, Chapter 1, Part 31, Subpart A, Sections 31.0-31.16, and Subpart B, Sections 31.200-31.204 and 31.400-31.402 of the Code of Federal Regulations.)

The following is a reprint of the official standards of the United States for grades of wool, the methods for determining the grade of wool, and procedures for distribution of samples representative of official standards of the United States for grades of wool and wool top promulgated by the Department of Agriculture under the Agricultural Marketing Act of 1946, as amended, (7 U.S.C. 1621, et. seq.) The standards are reprinted as adopted effective January 1, 1966.

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DEVELOPMENT OF THE STANDARDS

Grade standards for wool, as originally promulgated in 1926, were based on fiber diameter determined by visual examination, and the samples of wool representing these grades were classified visually. To determine grade by using these standards, the fiber fineness in the fleece was compared with that in the samples representative of the official grades. With advancements in objective sampling and measuring procedures for determining grade and in recognition of the limitations of the visual standards, the official standards for grades of wool were revised effective January 1, 1966. In this revision, two new grades--62's and 54's--were added to the original series of 12 grades, 80's through 36's, and provision also was made for grading wools finer than 80's and coarser than 36's. Grade determination was based on average fiber diameter and variation in fiber diameter. Average fiber diameter specifications and a maximum variability in fiber diameter

¹ These announcements were issued originally as Service and Regulatory Announcements No. 135 of the Bureau of Agricultural Economics.

in terms of microns were established for each of the 14 grades. The standards also provided that, if the variability in fiber diameter of wool being graded exceeded that specified as maximum for wools of that average fiber diameter, the wool was assigned the next coarser grade. Methods and procedures for determining the grade of wool by visual inspection and by measurement also were described and provision was made whereby certified samples representing the wool and wool top grades would be made available to the public at a specified price.

The revision of the standards in January 1966 followed proposed revisions in the standards in March 1955 and January 1963 which were not adopted. Both of these proposals also included the two new grades--62's and 54's--and the determination of grade also was based on measurements of the diameter of the wool fibers. In the 1955 proposal, grade was based on fiber diameter and fiber diameter dispersion. In the 1963 proposal, however, grade was based on average fiber diameter only but a fiber diameter uniformity guide was included for optional use with the grade standards.

OFFICIAL STANDARDS OF THE UNITED STATES FOR GRADES OF WOOL

Sec. 31.0 Official grades. The official grades of wool shall be those established in Secs. 31.1 through 31.16: Provided, however, That the wool which qualifies for any of the grades in Secs. 31.1 through 31.15 on the basis of its average fiber diameter shall be reduced in grade to the next coarser grade if its standard deviation in fiber diameter exceeds the maximum specified for the grade to which the average fiber diameter corresponds.

Sec. 31.1 Finer than grade 80's. Wool with an average fiber diameter of 17.69 microns or less and a standard deviation in fiber diameter of 3.59 microns or less.

Sec. 31.2 Grade 80's. Wool with an average fiber diameter of 17.70 to 19.14 microns, inclusive, and a standard deviation in fiber diameter of 4.09 microns or less.

Sec. 31.3 Grade 70's. Wool with an average fiber diameter of 19.15 to 20.59 microns, inclusive, and a standard deviation in fiber diameter of 4.59 microns or less.

Sec. 31.4 Grade 64's. Wool with an average fiber diameter of 20.60 to 22.04 microns, inclusive, and a standard deviation in fiber diameter of 5.19 microns or less.

Sec. 31.5 Grade 62's. Wool with an average fiber diameter of 22.05 to 23.49 microns, inclusive, and a standard deviation in fiber diameter of 5.89 microns or less.

Sec. 31.6 Grade 60's. Wool with an average fiber diameter of 23.50 to 24.94 microns, inclusive, and a standard deviation in fiber diameter of 6.49 microns or less.

Sec. 31.7 Grade 58's. Wool with an average fiber diameter of 24.95 to 26.39 microns, inclusive, and a standard deviation in fiber diameter of 7.09 microns or less.

Sec. 31.8 Grade 56's. Wool with an average fiber diameter of 26.40 to 27.84 microns, inclusive, and a standard deviation in fiber diameter of 7.59 microns or less.

Sec. 31.9 Grade 54's. Wool with an average fiber diameter of 27.85 to 29.29 microns, inclusive, and a standard deviation in fiber diameter of 8.19 microns or less.

Sec. 31.10 Grade 50's. Wool with an average fiber diameter of 29.30 to 30.99 microns, inclusive, and a standard deviation in fiber diameter of 8.69 microns or less.

Sec. 31.11 Grade 48's. Wool with an average fiber diameter of 31.00 to 32.69 microns, inclusive, and a standard deviation in fiber diameter of 9.09 microns or less.

Sec. 31.12 Grade 46's. Wool with an average fiber diameter of 32.70 to 34.39 microns, inclusive, and a standard deviation in fiber diameter of 9.59 microns or less.

Sec. 31.13 Grade 44's. Wool with an average fiber diameter of 34.40 to 36.19 microns, inclusive, and a standard deviation in fiber diameter of 10.09 microns or less.

Sec. 31.14 Grade 40's. Wool with an average fiber diameter of 36.20 to 38.09 microns, inclusive, and a standard deviation in fiber diameter of 10.69 microns or less.

Sec. 31.15 Grade 36's. Wool with an average fiber diameter of 38.10 to 40.20 microns, inclusive, and a standard deviation in fiber diameter of 11.19 microns or less.

Sec. 31.16 Coarser than grade 36's. Wool with an average fiber diameter of 40.21 microns or more.

DEFINITIONS

Sec. 31.200 Meaning of words. Words used in this part in the singular form shall be deemed to import the plural, and vice versa, as the case may demand.

Sec. 31.201 Terms defined. For the purposes of this part, unless the context otherwise requires, the following terms shall be construed respectively to mean:

(a) Department. The United States Department of Agriculture.

(b) Consumer and Marketing Service. The Consumer and Marketing Service of the Department.

(c) Administrator. The Administrator of the Consumer and Marketing Service, or any officer or employee of the Consumer and Marketing Service to whom authority has heretofore been delegated, or to whom authority may hereafter be delegated, to act in his stead.

(d) Division. The Livestock Division of the Consumer and Marketing Service.

(e) Director. The Director of the Division, or any officer or employee of the Division to whom authority has heretofore been delegated, or to whom authority may hereafter be delegated, to act in his stead.

(f) Grade. This term means a numerical designation of wool fineness based on average fiber diameter and variation of fiber diameter. It does not include characteristics such as length, crimp, strength, elasticity, luster, hand, and color, all of which affect the spinnability of a wool and the properties of the yarn and fabric and which are usually referred to as "quality." Neither does it apply to wool by geographic origin, breed of sheep, manner of preparation for market, or a combination of characteristics which makes wool appropriate for a specific use. These are usually referred to as "type."

(g) Wool. The fiber from the fleece of sheep.

(h) Wool top. A continuous untwisted strand of scoured wool fibers from which the shorter fibers or noils have been removed by combing.

(i) Fineness. This term refers to fiber diameter.

(j) Average fiber diameter. The sum of the individual fiber diameter measurements divided by the number of fibers measured, as described in Sec. 31.204(a).

(k) Micron. A unit of linear measurement equal to 1/1000 millimeter or 1/25400 inch.

(l) Grease wool. Wool, as obtained from living sheep.

(m) Scoured wool. Wool from which the bulk of the impurities have been removed by washing in warm water, soap, and alkali or by an equivalent process.

(n) Fleece. The wool of one sheep obtained by shearing.

(o) Skirted fleece. A fleece from which the belly, britch, and stained portions have been removed.

(p) Sorted wool. Wool removed from various parts of fleeces and combined into different groups or sorts, each of which has closely similar fineness, length, and other qualities.

(q) Pulled wool. Wool obtained from the pelts of slaughtered sheep by pulling or similar means after subjecting the pelt to sweating, the use of a depilatory, or other auxiliary treatment to loosen the wool fibers from the skin.

(r) Card sliver. Wool that has been scoured and carded and formed into a continuous, untwisted strand of loosely assembled fibers.

(s) Lot. The entire quantity of wool or card sliver constituting the subject of consideration or test.

(t) Sample. A suitable amount of wool representing a lot.

(u) Test specimen. A representative portion of the sample obtained and prepared as described in Sec. 31.204(a) (6).

(v) Test. A determination, by measurement, of the average and standard deviation in fiber diameter of test specimens of wool, in accordance with the procedures provided in Sec. 31.204.

(w) Core sampling. A method of coring a package of wool by means of special tools to obtain a representative sample of the wool according to the appropriate procedures described in Sec. 31.204(a) (5).

(x) Hand sampling. A method of drawing by hand many small handfuls of wool to obtain a representative sample of the wool according to the appropriate procedures described in Sec. 31.204(a) (5).

(y) Major sort. The wool of one grade that is greater by weight than any other grade in a fleece.

(z) Standards. The official standards of the United States for grades of wool and wool top.

(aa) Standard samples. Physical samples representative of the standards.

(bb) Bulk sample. A quantity of wool selected for use in the preparation of standard samples.

METHODS FOR DETERMINING GRADE OF WOOL

Sec. 31.202 General. The official standards of the United States for grades of wool, as defined in Secs. 31.1-31.16, shall be the basis of classification of wool by grade. Grade may be determined by inspection, usually by comparison of the fiber diameters of the wool being graded with the fiber diameters of samples representative of standards; or by measuring a prescribed number of fibers of a sample, calculating the average and standard deviation of fiber

diameter and comparing the average and standard deviation with the diameter specifications for grades of wool. The provisions in Secs. 31.203-31.204 prescribe methods for making such determinations. Both methods for determining grade shall be official; however, if the grade as determined by inspection differs from that determined by measurement, the grade determined by measurement shall prevail.

Sec. 31.203 Inspection method. Determination of the grade of wool by inspection frequently will be facilitated by comparing the fiber fineness of a sample of wool representative of the lot with the fiber fineness of valid standard wool samples representative of the official grades, in accordance with the procedure described in this section. A core sample is not satisfactory for determination of grade by the inspection method. When using the standard wool samples, the following procedures shall be followed:

(a) Procedure for wools not in fleece form. The fibers in the lot sample shall be compared with the fibers in the standard wool samples. The grade of the lot shall be designated as the grade corresponding to the standard wool sample which the lot sample most nearly matches in fineness.

(b) Procedure for fleeces. (1) For fleeces that have a major sort, the grade of the major sort shall be determined in accordance with the procedure specified in paragraph (a) of this section, and this shall be designated as the grade of the fleece.

(2) For fleeces that do not have a major sort, the grade of the entire fleece shall be determined in accordance with the procedure specified in paragraph (a) of this section.

Sec. 31.204 Measurement method. The determination of the grade of wool by measurement shall be by comparison of the measured average and standard deviation of fiber diameter with the specifications of the United States standards. This determination shall be made in accordance with the procedure for determining average and standard deviation of fiber diameter provided in paragraph (a) of this section and the procedure for designating grade provided in paragraph (b) of this section.

(a) Procedure for determining average and standard deviation of fiber diameter--(1) Scope. The procedure set forth in this section shall be used in the determination of the average and standard deviation of fiber diameter of grease wool, scoured wool, pulled wool, or wool in the form of card sliver.

(2) Principle of procedure. The average and standard deviation of fiber diameter are determined by sectioning the fibers in a specimen to a designated short length, mounting the sections on a slide, projecting the magnified image onto a scale, and measuring the diameter of a specified minimum number of the fibers, randomly selected, as specified in this section.

(3) Apparatus and material. The following apparatus and material are needed and shall comply with the following provisions:

(i) Microprojector. The microscope shall be equipped with a fixed body tube, a focusable stage responsive to coarse and fine adjustments, and a focusable substage with condenser and iris diaphragm (fig. 1). It shall be vertically installed with adequate light source, eyepiece, and objective to give a precise magnification of 500X as determined by use of a stage micrometer. A magnification of 500X can be obtained when the microscope is adjusted at a proper projection distance and equipped with a searchlight micro-projector bulb, a 10 to 15X eyepiece, and a 20 to 21X objective

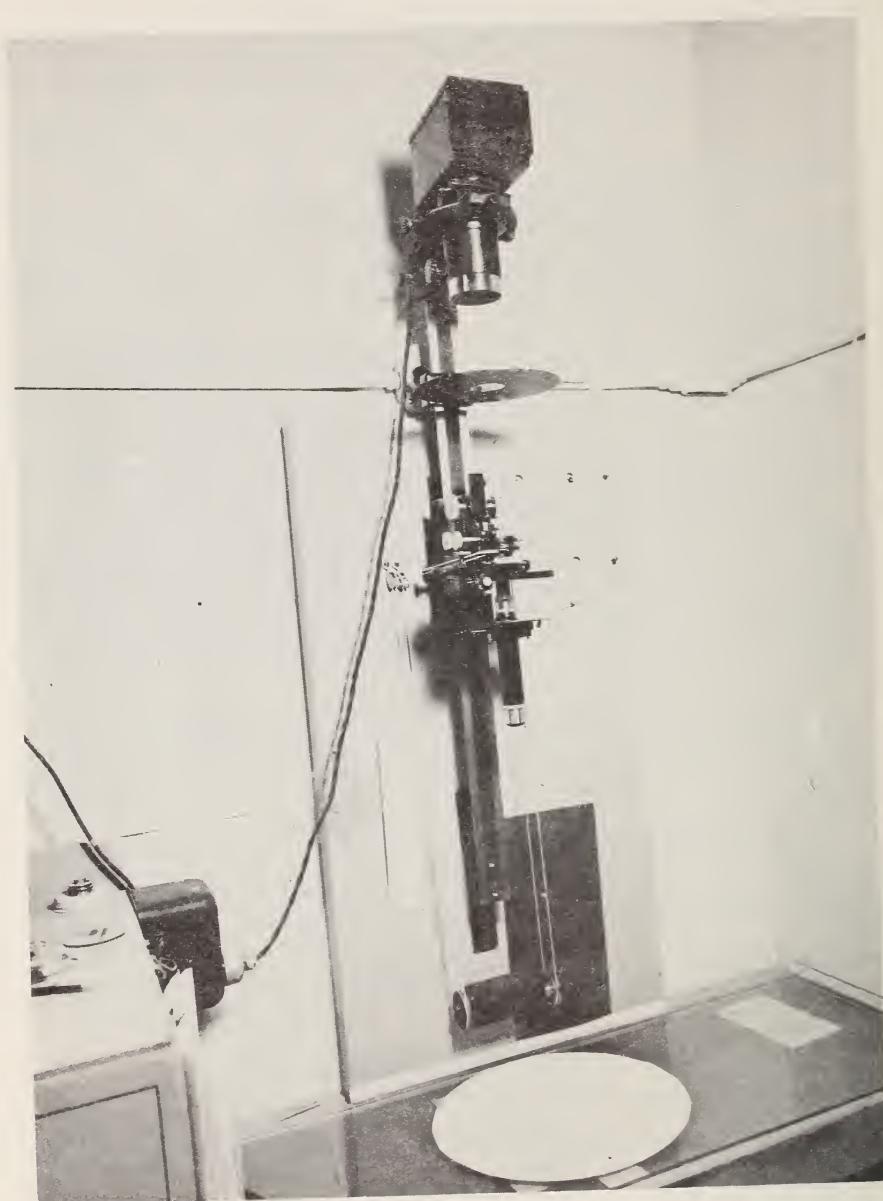


Figure 1. Microprojector.

of good quality with an aperture of approximately 0.50 centimeter.

(ii) Stage micrometer. Calibrated glass slide used for accurate setting and control of the magnification.

(iii) Cross sectioning device, heavy duty. An instrument approximately 2 inches in height, consisting essentially of a metal plate with slot for holding a quantity of fibers, a key for compressing the fibers, and a tongue-propelling arrangement by which the fiber bundle may be extruded for sectioning (fig. 2).

(iv) Microscope slides. 1" x 3" (25 x 75 mm).

(v) Cover glasses. No. 1 thickness, 7/8" x 2" (22 x 50 mm).

(vi) Mounting medium. Colorless mineral oil with a refractive index between 1.53 and 1.43, and of suitable viscosity.

(vii) Wedge scales. Strips of heavy paper or Bristol board, imprinted with a wedge for measurement of fiber diameter at a magnification of 500X. The wedge is usually divided into 2.5 micron intervals (cells) (fig. 3).

(4) Calibration. The microscope shall be adjusted to give a magnification of 500X in the plane of the projected image. This may be accomplished by placing a stage micrometer on the stage of the microprojector and bringing the microscope into such adjustment that an interval of 0.20 mm on the stage micrometer will measure 100 mm when sharply focused in the center of the image plane.

(5) Sampling. The method of obtaining a sample representative of the fineness of a lot of grease wool, pulled wool, scoured wool, or card sliver will differ according to circumstances. Lots may be sampled either by coring or by hand. The sampling procedures, advisable are as follows:

(i) Core sampling. Core sampling of packaged scoured, pulled, or grease wool is advisable whenever feasible (fig. 4). Acceptable procedures and schedules for core sampling raw wool are described in current ASTM Standards on Textile Materials, Designation: D1060, "Standard Method of Core Sampling of Raw Wool Packages for Determination of Percentage of Clean Wool Fiber Present."¹ If a representative portion of the scoured wool core sample resulting from the test for clean wool fiber content is available, it may be used for average and standard deviation of fiber diameter determinations if the procedures described in ASTM Designation: D584, "Standard Methods of Tests for Wool Content of Raw Wool,"² are followed.

(ii) Hand sampling an individual fleece. A sample shall consist of approximately 30 grams of wool. For fleeces having a major sort, the sample shall be drawn at random from this part of the fleece. For fleeces not having a major sort, the sample shall be drawn at random from all parts of the fleece.

(iii) Hand sampling lots of fleece. A sample shall consist of at least 3 pounds of wool. If the fleeces are packaged, the sample shall be drawn from at least 50 randomly selected fleeces from not less than 10 percent of randomly selected packages in the lot. If the fleeces are in piles, the sample shall be drawn from at least 50 fleeces selected from random locations throughout the pile. If there are less than 50 fleeces in the lot, all fleeces shall be sampled. Each fleece shall be sampled in accordance with the provisions in subdivision (ii) of this subparagraph.

¹ Copies of D1060 and D584 may be purchased from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa., 19103.

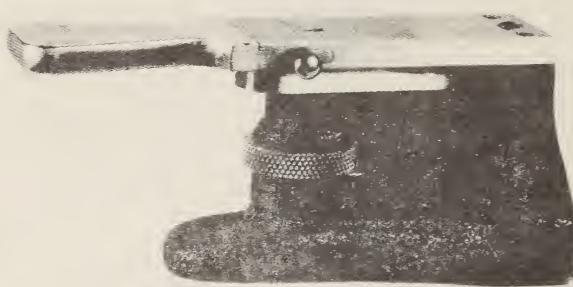


Figure 2. Heavy duty cross sectioning device.

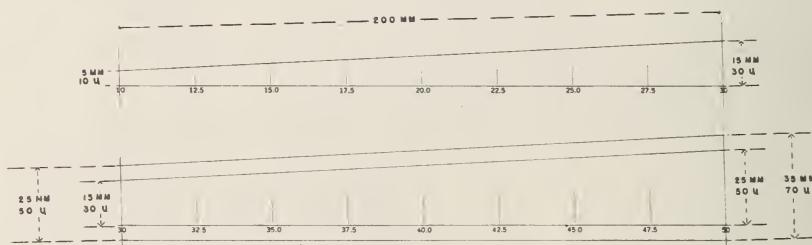


Figure 3. Wedge scales.



Figure 4. Core sampling a bag of grease wool.

(iv) Hand sampling lots of scoured, pulled, and grease wool not in fleece form. A sample shall consist of at least 3 pounds of wool. If the wool is packaged, the sample shall be drawn by taking a total of at least 50 handfuls of wool from not less than 10 percent of randomly selected packages in the lot. If the wool is in piles, the sample shall be drawn by taking from random locations throughout the pile at least 50 handfuls of wool.

(v) Hand sampling card sliver. Wool card sliver shall be sampled by drawing at random from the lot, preferably during the carding operation, ten 24-inch lengths of sliver.

(6) Test specimens of grease wool, pulled wool, scoured wool, and card sliver. The method of obtaining a test specimen representative of a sample drawn in accordance with the procedures of subparagraph (5) of this paragraph will differ according to circumstances. The methods advisable are as follows:

(i) Obtaining test specimen from core test residue. The test specimen shall be obtained from one or more aliquot portions of the scoured wool remaining after core testing of a lot for clean fiber content by using the following procedure: The sample shall be divided into 40 portions of approximately equal size. From each portion, a sufficient quantity of fibers shall be drawn at random to provide an aggregate test specimen of 20 grams (fig. 5). These fibers shall be mixed or blended to form the test specimen. For best blending results, test specimens from samples obtained by means of 1 1/4-inch and larger coring tubes should be machine blended. However, samples drawn with smaller tubes should not be machine blended since loss of fiber may occur. The machine blending of test specimens may be accomplished by carding the specimen 3 times, breaking the web and feeding at right angles after the first and second passes; or by gilling the specimens 15 times, breaking and combining the pieces of sliver to maintain a convenient length.

(ii) Obtaining test specimens from other samples (except card sliver). Test specimens may be obtained by hand sampling or core sampling as described herein:

(a) Hand sampling. Samples shall be divided into 40 portions of approximately equal size. From each portion, a sufficient quantity of fiber to provide a test specimen of 20 grams shall be drawn at random. Test specimens of grease wool and pulled wool shall be scoured or otherwise cleaned. Clean specimens, except those from samples of wool with fibers less than 1 1/4 inches in length, shall be further homogenized, preferably by machine blending, following the procedures described in subdivision (i) of this subparagraph.

(b) Core sampling. The sample shall be compressed in a suitable container (fig. 6). By means of a 3/8-inch or a 1/2-inch coring tube with sharp tip, a sufficient number of cores shall be extracted to provide a test specimen of 20 grams of scoured wool. Test specimens of grease wool or pulled wool shall be scoured or otherwise cleaned.

Note: An example of a suitable container would be a box 12 inches by 10 inches by 6 inches deep, equipped with a floating top which has 16 randomly spaced holes three-fourth inch in diameter over its area. The wool may be firmly compressed by applying pressure on the top. The top is held in place by two rods extending through holes in the side of the box and over the top. The coring tube is thrust through the holes in the top to sample the wool (fig. 6).



Figure 5. Sampling core test residue to obtain test specimen.



Figure 6. A small diameter pressure coring tube and compression box for obtaining test specimens from small samples of grease, pulled or scoured wool.

(iii) Obtaining test specimens from card sliver samples. Portions shall be stripped from each of the ten 24-inch pieces of sliver obtained in accordance with subparagraph (5) (v) of this paragraph. These pieces shall be combined to form a composite sliver about 2 feet in length. This will constitute the test specimen (fig. 7).

(7) Test condition. Precondition all test specimens to approximate equilibrium in an atmosphere of 5 to 25 percent relative humidity at a temperature less than 122° F. (50° C.). Then condition them for at least 4 hours in the standard atmosphere for testing, 65 percent relative humidity \pm 2 percent at 70° F. \pm 2° F. (21° \pm 1.1° C.) in temperature.

(8) Preparation of slides--(i) Filling cross section device. For specimen in sliver form, the specimen shall be placed in the slot of the cross section device, far enough from either end of the sliver to assure sectioning at an undisturbed area. It shall be compacted firmly with the compression key, and the latter secured with the set screw. For specimen not in sliver form, from the bulk of the test specimen, small quantities of fibers shall be drawn at random, packing the slot to the required level (fig. 8). The specimen shall be compacted firmly with the compression key, and the latter secured with the set screw.

(ii) Preliminary section. The gripped fibers shall be cut off at the upper and lower surfaces of the plate. The fiber bundle shall be extruded to the extent of approximately 0.50 mm in order to take up slack in the fibers and the propulsion mechanism. The projecting fibers shall be moistened with a few drops of mineral oil. This projecting fiber bundle shall be cut off with a razor blade flush with the upper surface of the fiber holder plate, and the section discarded.

(iii) Final section. The fiber bundle shall again be extruded, approximately 0.25 mm. The fiber bundle shall be moistened with a few drops of mineral oil, blotting off the excess. The projecting fibers shall be cut off with a sharp razor blade flush with the holder plate. The fiber pieces should adhere to the razor blade (fig. 9).

(iv) Mounting the fibers. A few drops of mineral oil shall be placed on a clean glass slide. With a dissecting needle, the fiber pieces shall be scraped from the razor blade onto the slide (fig. 10). The fibers shall be thoroughly dispersed in the oil with the dissecting needle and the slide completed with a cover glass (fig. 11). Sufficient oil should be used in the preparation of the slide to insure thorough distribution of the fibers, but an excess must be avoided, as practically no oil should be permitted to flow out or be squeezed out beyond the borders of the cover glass. If the number of fibers is too great to permit proper distribution on the slide, or if an excess of oil has been used, a portion of the mixture, after thorough dispersion of the fibers, may be wiped away with a piece of tissue or cloth.

(v) Finished slide. The slide shall be placed on the stage of the microprojector, cover glass toward the objective. The measurement courses shall be planned across the slide so that the far, near, and intermediate areas will be reached. Slides shall be measured the day they are prepared.

(9) Measurement of fibers. Starting at the upper left corner on the slide, the midlength portion of the fiber to be measured shall be brought into sharp focus on the wedge scale. Fiber edges appear as fine lines without borders when they are uniformly in



Figure 7. Sampling card sliver to obtain test specimens.



Figure 8. Representative portions of scoured wool being packed in slot of cross section device.



Figure 9. Cutting final section of fibers from test specimen. Note fiber pieces adhering to the razor blade.

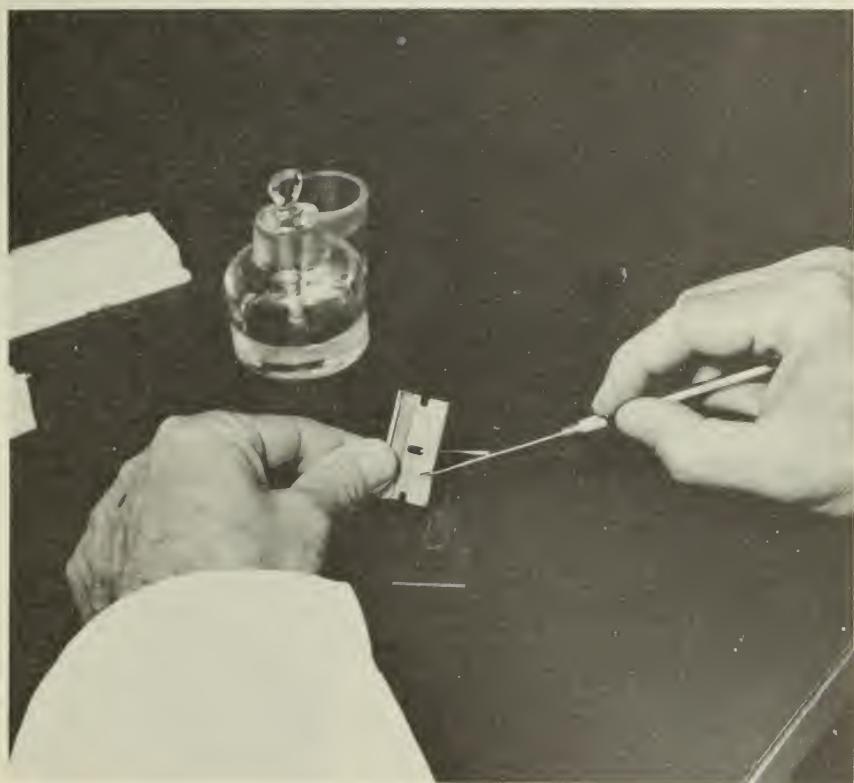


Figure 10. Scraping fibers from the razor blade onto mineral oil on a clean slide.

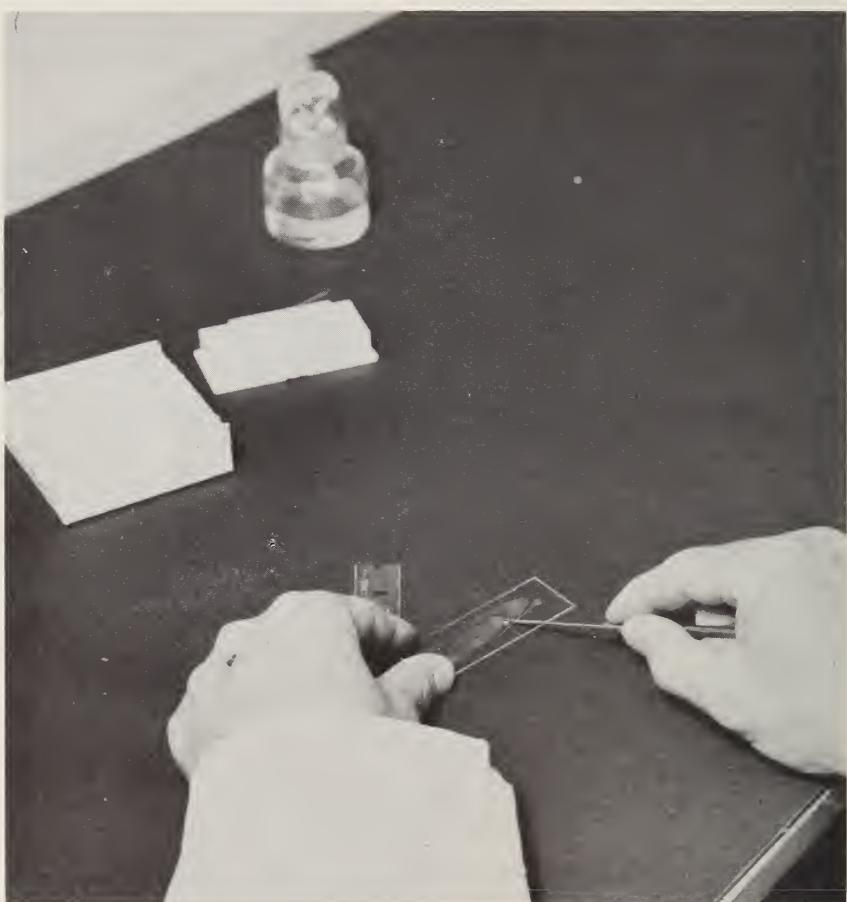


Figure 11. Dispensing of fibers thoroughly in mineral oil with dissecting needle.

focus. It is unusual, however, for both edges of the fiber to be in focus at the same time (fig. 12). If both edges of the fiber are not uniformly in focus, adjustment shall be made so that one edge of the fiber is in focus and the other shows as a bright line. To record the measurement, it is necessary to mark the point where the wedge corresponds with the fiber image as determined by (i) the fine lines of both edges when they are uniformly in focus, or (ii) the fine line of one edge and the inner side of the bright line at the other edge when they are not uniformly in focus (fig. 13). The slide shall be traversed and successive fibers measured in the planned courses, measuring only those fibers whose midpoints come within the field--a circle 4 inches in diameter, centrally located in the projected area. Fibers shorter than 150 microns in length, and those having distorted images shall be excluded from measurement. The marks on the wedge indicating the diameter of fibers measured are counted and combined into cells for calculation as indicated in Sec. 31.204(a) (12).

(10) Nature of test. A test shall comprise the measurement of the test specimen by two operators, each operator following independently the procedures of subparagraph (8) of this paragraph.

(11) Number of fibers. The minimum number of fibers required for each test shall be the number for the respective grade as prescribed in the procedure for designating grade (paragraph (b) of this section), each operator measuring approximately one-half the required number of fibers. The prescribed minimum number of fibers per test should result in confidence limits of the mean ranging from approximately ± 0.4 to ± 0.5 micron at a probability level of 95 percent, when wools of average uniformity in fiber fineness are measured.

(12) Calculation and report. The measurements of both operators shall be combined and the following calculations made by using the applicable formulae shown below:

- (i) Total number of measurements (n)
- (ii) The average diameter of fiber (\bar{X}); $\bar{X} = A + mE_1$
- (iii) The standard deviation (σ); $\sigma = m \sqrt{E_2 - E_1^2}$

In the formulae stated above:

A = Midpoint of cell containing the smallest measurement

m = Cell interval

$$E_1 = \frac{\sum fx}{n}$$

$$E_2 = \frac{\sum fx^2}{n}$$

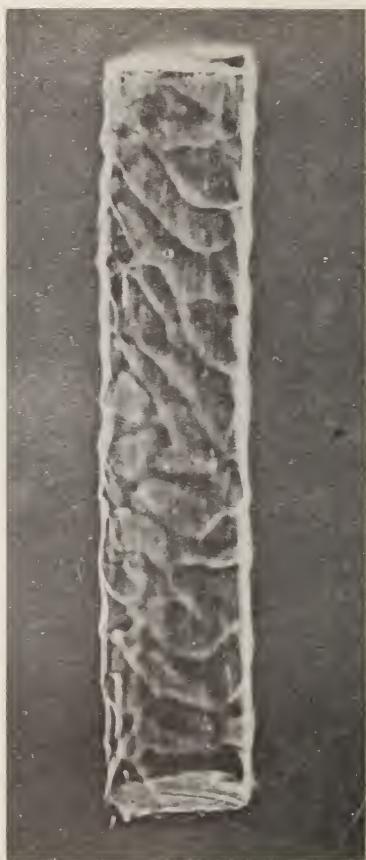
Σ = Summation

f = Observed frequency

x = Deviation in cells from A



Correct



Incorrect

Figure 12. Correctly and incorrectly focused fiber.

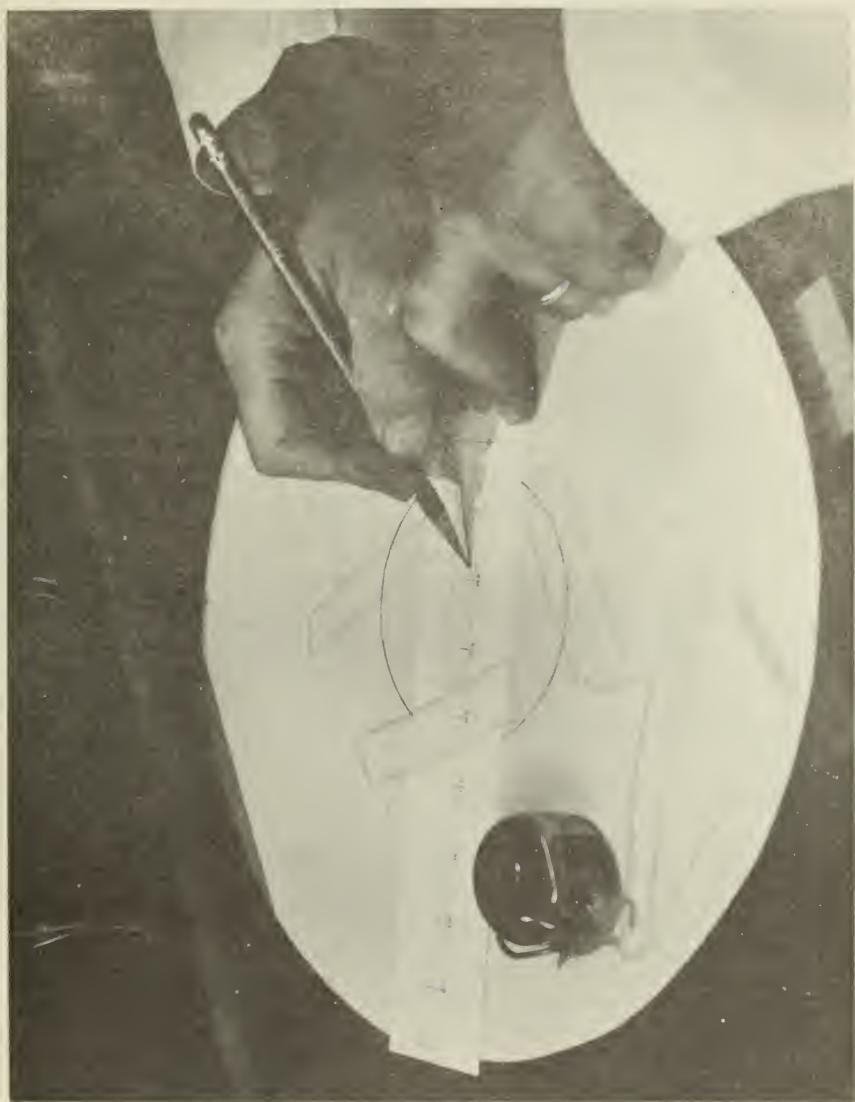


Figure 13. Marking wedge scale at point where wedge and fiber image correspond.

An example of the calculations is set forth below:

Example of Calculations: Average Fiber Diameter and Standard Deviation

Cell No.	Cell boundary	A	Deviation in cells from A, x	Observed frequency f	fx	fx ²
5	10.0-12.5	11.25	0	1	0	0
6	12.5-15.0	....	1	12	12	12
7	15.0-17.5	....	2	53	106	212
8	17.5-20.0	....	3	113	339	1,017
9	20.0-22.5	....	4	132	528	2,112
10	22.5-25.0	....	5	141	705	3,525
11	25.0-27.5	....	6	111	666	3,996
12	27.5-30.0	....	7	79	553	3,871
13	30.0-32.5	....	8	63	504	4,032
14	32.5-35.0	....	9	44	396	3,564
15	35.0-37.5	....	10	28	280	2,800
16	37.5-40.0	....	11	7	77	847
17	40.0-42.5	....	12	6	72	864
18	42.5-45.0	....	13	5	65	845
19	45.0-47.5	....	14	3	42	588
20	47.5-50.0	....	15	0	0	0
21	50.0-52.5	....	16	2	32	512
Total . . . . .	.....	....	.....	800	4,377	28,797

Number of measurements (n) = 800

A (midpoint of cell containing smallest diameter measurement) = 11.25 microns

m (cell interval) = 2.5 microns

$$E_1 = \left(\frac{\Sigma fx}{n} \right) = \frac{4377}{800} = 5.4712 \text{ and } E_2 = \left(\frac{\Sigma fx^2}{n} \right) = \frac{28,797}{800} = 35.9962$$

$$\text{Average diameter, } \bar{X} = A + mE_1 = 11.25 + 2.5(5.4712) = 24.93 \text{ microns*}$$

$$\text{Standard deviation, } \sigma = m \sqrt{E_2 - E_1^2} = 2.5 \sqrt{35.9962 - 29.9340} = 2.5(2.4622) = 6.16 \text{ microns*}$$

*Round off the calculated values of average fiber diameter and of standard deviation to two decimal places as follows: If the figure in the third decimal place is 4 or less, retain the figure in the second decimal place unchanged; otherwise, increase the figure in the second decimal place by 1.

(b) Procedure for designating grade. For grade determination by measurement, the minimum number of fibers to be measured per test based on the average fiber diameter limits of the various grades is set forth below.

Measurement Schedule for Designating Grades of Wool

Grade	Minimum number of fiber diameter measurements	Limits for average fiber diameter (microns)	Limit for standard deviation, maximum (microns)
Finer than 80's.	400	Under 17.70 . . .	3.59
80's	400	17.70 to 19.14 . .	4.09
70's	400	19.15 to 20.59 . .	4.59
64's	600	20.60 to 22.04 . .	5.19
62's	800	22.05 to 23.49 . .	5.89
60's	800	23.50 to 24.94 . .	6.49
58's	1,000	24.95 to 26.39 . .	7.09
56's	1,200	26.40 to 27.84 . .	7.59
54's	1,400	27.85 to 29.29 . .	8.19
50's	1,600	29.30 to 30.99 . .	8.69
48's	1,800	31.00 to 32.69 . .	9.09
46's	2,000	32.70 to 34.39 . .	9.59
44's	2,200	34.40 to 36.19 . .	10.09
40's	2,400	36.20 to 38.09 . .	10.69
36's	2,600	38.10 to 40.20 . .	11.19
Coarser than 36's.	2,600	Over 40.20 . . . . .	.....

(1) Grade designation. That grade shall be assigned to a sample of wool which corresponds, in the measurement schedule for designating grades of wool, to the measured average and standard deviation of fiber diameter, provided this is determined in accordance with the procedure set forth in paragraph (a) of this section. Example: Measured average fiber diameter equals 27.25 microns; number of fiber diameter measurements equal 1200; standard deviation equals 6.72 microns; grade designation equals 56's. If the measured standard deviation exceeds the maximum specified for the grade to which the measured average fiber diameter corresponds, assign to the wool the next coarser grade. Example: Measured average fiber diameter equals 27.25 microns; number of fiber diameter measurements equal 1200; standard deviation equals 7.80 microns; grade designation equals 54's. Example: Measured average fiber diameter equals 27.25 microns; number of fiber diameter measurements equals 1200; standard deviation equals 8.50 microns; grade designation equals 54's.

(2) Interpretation. Since all the wool in a lot may not be of the same grade, the grade determined by measurement represents only the average grade of the entire lot. It should not be construed to represent the grade of any component part of the lot selected on a nonrandom basis.

SAMPLES REPRESENTATIVE OF OFFICIAL GRADE STANDARDS OF THE UNITED STATES FOR WOOL AND WOOL TOP

Sec. 31.400 Standard samples for wool and wool top grades; method of obtaining. Samples certified as representative of the official standards of the United States for grades of wool and wool top will be furnished as follows, subject to other conditions of this section, upon filing of an approved application and prepayment of costs thereof as fixed in Secs. 31.401 and 31.402. The certification will be issued by the United States Department of Agriculture and will be signed by the Director of the Livestock Division or other official duly authorized by him.

(a) Samples representative of each of the standard grades of wool:

(1) Complete set: Grades 80's through 36's. Fourteen samples, each of approximately 1/8 pound grease wool (fig. 14), or

(2) Individual sample: Individual samples of approximately 1/8 pound of grease wool (fig. 15).

Note: A sample consists of wool randomly selected from a bulk sample. The measured average and standard deviation of fiber diameter of the bulk sample are within the limits corresponding to the grade of the standard sample as set forth in Secs. 31.2 through 31.15.

(b) Samples representative of each of the standard grades of wool top;

(1) Complete set: Grade 80's through 36's. Fourteen samples, each of approximately 3 ounces wool top (fig. 16), or

(2) Individual sample: Individual samples of approximately 3 ounces of wool top, representing a standard grade (fig. 17).

(c) Each application for standard samples of wool or wool top shall be upon an application form furnished or approved by the Consumer and Marketing Service, shall be signed by the applicant, and shall be accompanied by certified check, draft, post office money order, or express money order, payable to the "Consumer and Marketing Service," in an amount to cover the cost of the samples requested, and shall incorporate the following agreement:

(1) That no samples representative of the official wool or wool top standards shall be considered or used as representing such standards after cancellation in accordance with this section.

(2) That the said standard samples shall be subject to inspection by the Secretary or by any duly authorized officer or agent of the Department of Agriculture during usual business hours of the person having custody of the samples.

(3) That the certificate covering any of the samples representative of the standards may be revoked and canceled by the Director of the Livestock Division if it is found upon such inspection that the said samples are not representative of the official standards.

Sec. 31.401 Cost of standard samples for wool grades.

(a) Complete set: \$22 each, delivered to any destination within the United States and \$24 each, delivered to any destination outside the United States.

(b) Individual sample: \$2 each, delivered to any destination within the United States and \$2.50 each, delivered to any destination outside the United States.

Sec. 31.402 Cost of standard samples for wool top grades.
(a) Complete set: \$42 each, delivered to any destination within the United States and \$44 each, delivered to any destination outside the United States.

(b) Individual sample: \$3 each, delivered to any destination within the United States and \$3.50 each, delivered to any destination outside the United States.

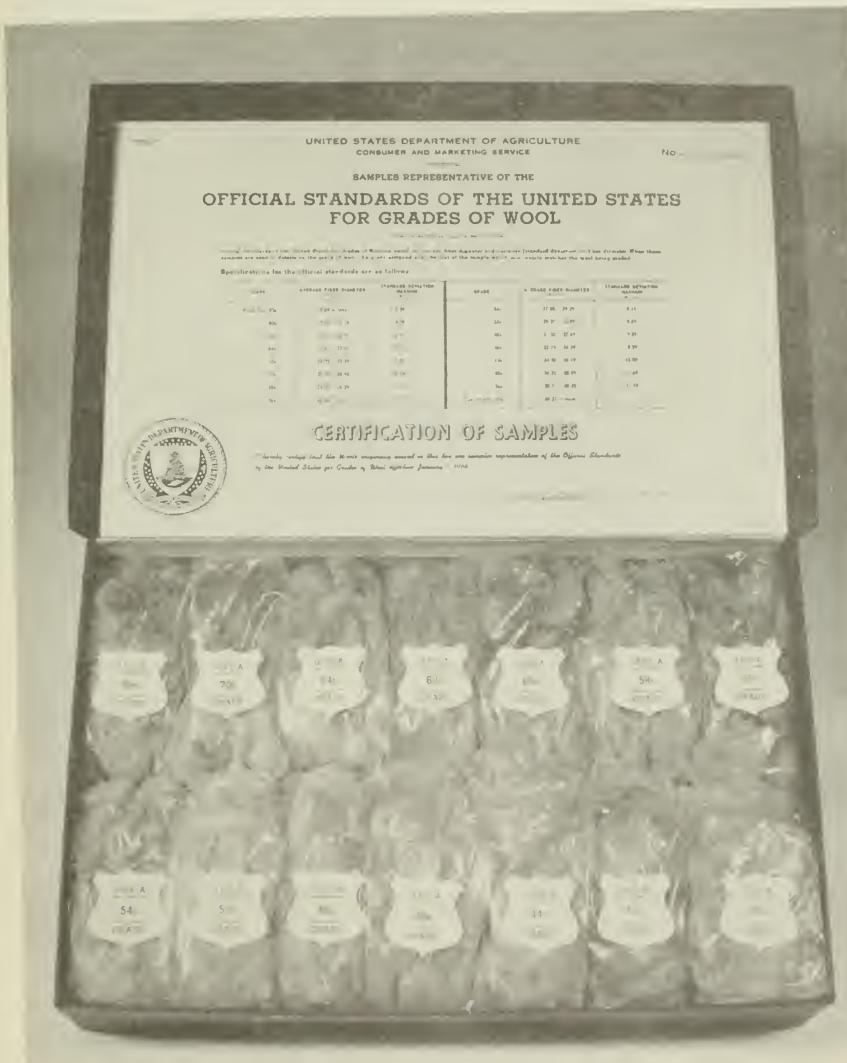


Figure 14. Complete set of samples representative of the official grade standards of the United States for grades of wool.

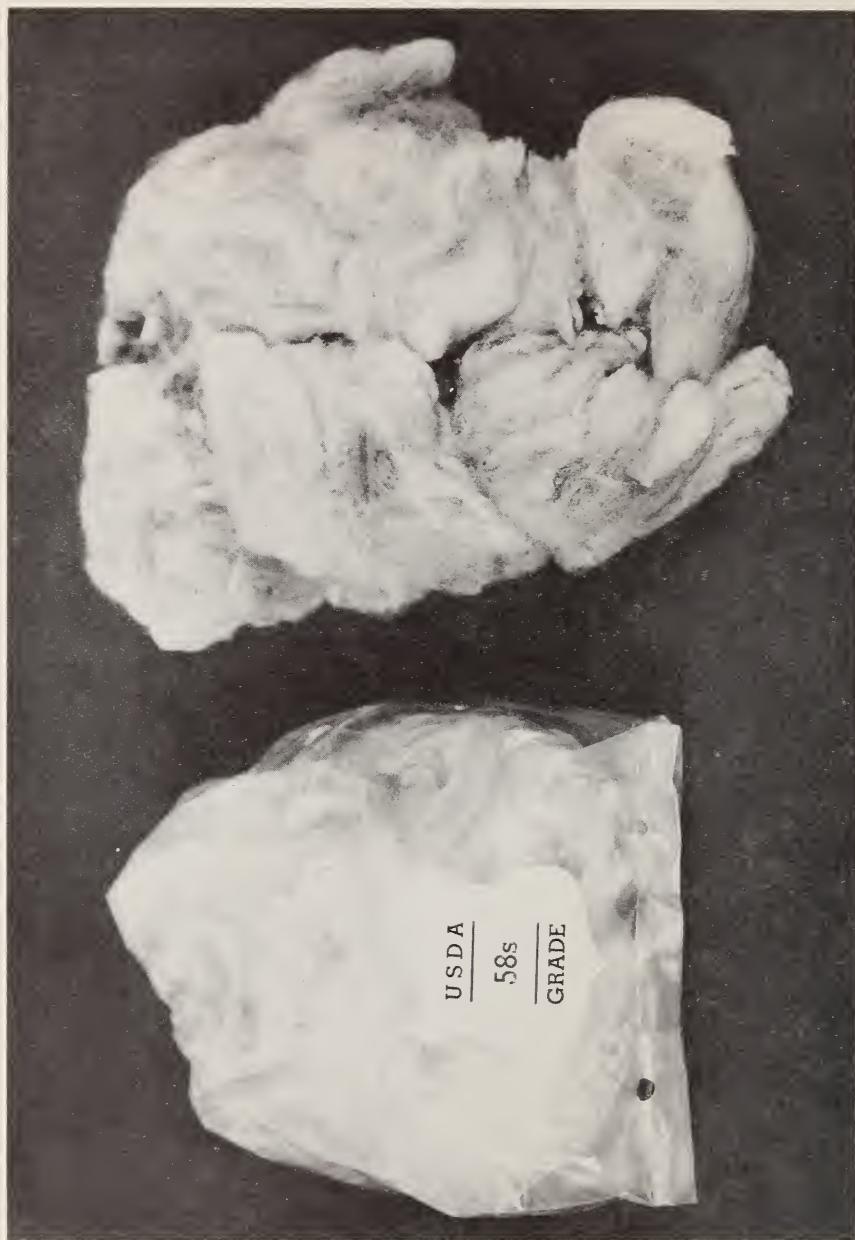


Figure 15. An individual sample representative of grade 58s wool. Each sample is made up of approximately 1/8-pound of grease wool.

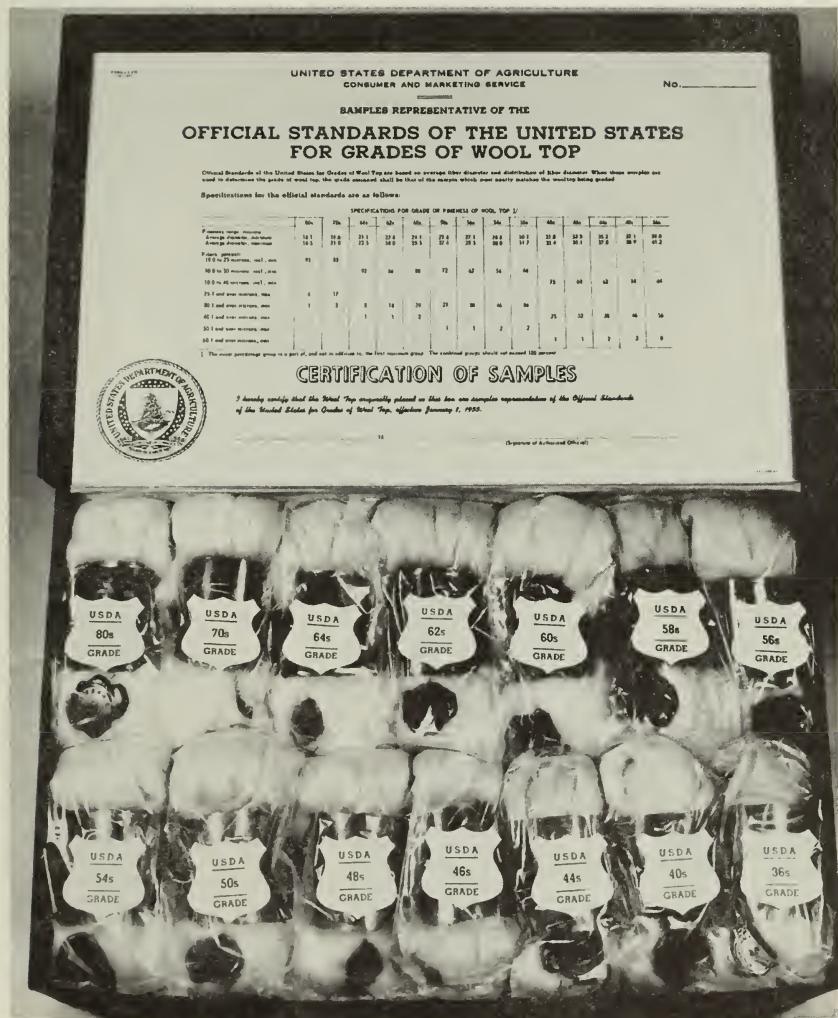




Figure 17. An individual sample representative of grade 64s wool top. Individual samples are made up of approximately 3 ounces of wool top.

APPENDIX

In sampling for fiber fineness and variability, the measurement method, Section 31.204, makes reference to ASTM Standards on Textile Materials, Designation: D 1060, "Standard Method of Core Sampling of Raw Wool Packages for Determination of Percentage of Clean Wool Fiber Present," as a source of acceptable procedures and schedules for core sampling raw wool for determining average and standard deviation of fiber diameter. Certain parts of Table 1 and all of Table 2 are taken from ASTM: D 1060 and reprinted herein as a ready source of core sampling information.

Table 1 is a sampling schedule giving the number of packages to be sampled, for selected pairs of values of σ_w and σ_b and for selected lot sizes, and numbers of cores per package for a fixed sampling precision of ± 1.0 at a probability level of 0.95 for percentage of clean wool fiber present. Average values of σ_w and σ_b for lots of several types of wool are listed in Table 2. When no reliable estimates are available, it is recommended that the conservative values of 5.0 be used for both σ_w and σ_b when sampling is performed in accordance with ASTM: D 1060.

TABLE 1. Values of n Calculated From Equation 1^a For a Precision of ± 1.0 At A Statistical Probability of 0.95, For Selected Values of σ_w , σ_b and k.

σ_w	σ_b	Number of Cores per Sampled Package, k	Number of Packages in Lot, N						
			25	50	75	100	150	200	300
			Number of Packages to be Sampled, n						
1.0	1.0	1	7	8	8	8	8	8	8
1.5	1.5	1	14	16	16	17	17	18	18
	4.0	1	21	32	40	45	52	56	61
2.0	5.0	1	24	39	50	58	70	78	87
		2	22	36	47	54	65	72	81
2.5	1.5	1	25	29	31	32	32	33	33
		2	16	19	20	20	21	21	21
2.5	2.5	1	25	34	38	40	43	45	47
		2	19	25	29	30	33	34	35
3.0	1.5	1	b	39	41	42	43	43	44
		2	20	23	25	25	26	26	27
3.0	2.5	1	b	41	46	49	53	55	57
		2	22	29	33	35	37	39	40
3.5	1.5	1	b	50	52	53	55	56	57
		2	b	29	30	31	32	32	33
3.5	2.0	4	16	18	19	20	20	21	21
		4	16	18	19	20	20	21	21
		1	b	50	54	56	59	61	62
		2	25	31	34	35	37	38	39
		4	18	22	24	25	26	27	27

TABLE 1. Values of n Calculated From Equation 1^a For A Precision of ± 1.0 At A Statistical Probability of 0.95, For Selected Values of σ_w , σ_b and k.--Continued

σ_w	σ_b	Number of Cores per Sampled Package, k	Number of Packages in Lot, N						
			25	50	75	100	150	200	300
			Number of Packages to be Sampled, n						
3.5	2.5	1	b	50	56	60	64	66	69
		2	25	33	37	40	42	44	46
		4	19	25	28	30	32	34	35
3.5	3.0	1	b	50	58	63	69	72	76
		2	25	36	41	45	49	52	54
		4	20	28	33	36	39	41	43
3.5	3.5	1	b	50	60	66	74	79	85
		2	25	38	45	50	56	59	64
		4	21	31	37	42	47	50	53
3.5	5.0	1	b	50	64	75	90	100	112
		2	25	42	54	63	75	84	94
		4	23	38	49	57	68	75	85
4.0	3.5	1	b	b	69	76	86	91	97
		2	b	41	49	55	61	65	70
		4	22	23	40	44	49	53	56
4.5	2.0	1	b	b	b	84	88	90	92
		2	b	43	47	49	51	53	54
		4	23	28	30	32	33	34	35
5.0	2.0	1	b	b	b	100	105	108	111
		2	b	50	55	57	60	62	63
		4	25	31	34	36	37	38	39
5.0	5.0	1	b	b	b	100	120	134	150
		2	b	50	65	75	90	100	113
		4	25	42	54	63	75	84	94

a. The sampling schedules in this table are based on a precision of ± 1.0 at a statistical probability of 0.95, calculated as follows:

$$n = \frac{N(\sigma_w^2 + k\sigma_b^2)}{kN \left(\frac{E}{t} \right)^2 + k\sigma_b^2}$$

where:

n = number of packages to be selected for coring,

N = number of packages in lot,

k = number of cores to be taken from each package,

E = required sample precision, in percentage of clean wool fiber present

t = probability factor,

σ_w^2 = variance (of the percentage of clean wool fiber present) of individual cores within packages in a lot, and

σ_b^2 = variance (of the percentage of clean wool fiber present) of packages in a lot.

b. The specified precision cannot be obtained with number of cores, k , per package.

TABLE 2. Estimates of σ_w and σ_b For Percentage of Clean Wool Fiber Present in Commercial Lots of Several Classes of Wool

Classification	σ_w	σ_b
A. Apparel Wool, Foreign:		
(1) Greasy, not burry:		
Argentine.....	2.5	2.5
Australia.....	1.5	4.0
Brazil.....	2.5	2.5
Canada.....	4.5	2.0
Chile.....	2.0	5.0
Peru, wool.....	2.5	2.5
Peru, alpaca.....	3.0	1.5
New Zealand.....	1.5	4.0
South Africa.....	1.5	4.0
Uruguay.....	3.0	1.5
(2) Pulled, not burry:		
Slight lime, all types.....	1.5	1.5
Heavy lime, all types.....	2.5	2.5
(3) Scoured, not burry:		
Well scoured, all types.....	1.0	1.0
Poorly scoured, all types.....	1.5	1.5
(4) Burry:		
5 to 10 percent bur, scoured basis.....	increase corresponding not burry σ_w by 1.0	
Over 10 percent bur, scoured basis		
B. Apparel Wool, Domestic:		
(1) Original bags, ungraded.....	4.5	2.0
(2) Territory wool, graded.....	4.5	2.0
(3) Fleece wools, graded.....	5.0	2.0
C. Carpet Wool:		
(1) Washed or greasy, not burry:		
Aleppo.....	3.0	2.5
B. A.	3.5	2.5
Blackface.....	4.0	3.5
India (other than Vicanere):		
White	2.5	1.5
Colored	3.5	3.0
Iran	3.5	3.5
Iraq	3.5	2.0
N. Z. Crutchings	3.5	5.0
Pakistan	2.0	5.0
Vicanere.....	3.0	2.5

TABLE 2. Estimates of σ_w and σ_b For Percentage of Clean Wool Fiber Present in Commercial Lots of Several Classes of Wool (Continued)

Classification	σ_w	σ_b
(2) Washed or greasy, burry: 5 to 10 percent bur, scoured basis.....	increase corresponding not burry σ_w by 1.0	
Over 10 percent bur, scoured basis.....		increase corresponding not burry σ_w by 2.0
(3) Pulled or colored	Same as washed or greasy, burry, 5 to 10 percent	
(4) Scoured, not burry: Well scoured, all types.....	1.0	1.0
Poorly scoured, all types.....	1.5	1.5
(5) Scoured, burry: 5 to 10 percent bur	2.5	1.5
Over 10 percent bur.....	3.5	1.5